Role of Diffusion MRI in renal cell carcinoma: assessment of nuclear grade

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Purpose: The American cancer society 2013 estimates new cases of renal cell carcinoma to be approximately 5% in male and 3% in female. Overall, the lifetime risk for developing kidney cancer is about 1 in 63 (1.6%).[1] Increase in detection of RCC is partly due to the growing use of abdominal imaging and the majority of these tumors are smaller in size.[2] Imaging techniques such as computed tomography (CT), ultrasound and magnetic resonance imaging (MRI) have shown their potential in RCC.[3] Prognosis of the patient depends upon aggressiveness and the stage of the disease. Aggressiveness of RCC is assessed on Fuhrman's nuclear grade of the resected specimen. Aggressiveness of RCC is assessed on Fuhrman's nuclear grade. Recently, diffusion-weighted MRI (DW-MRI) assessed RCC lesions non-invasively. The aim of the current study was to prospectively evaluate the role of ADC in patients with RCC and to assess the nuclear grade which could influence the management decisions in such patients non-invasively.

Materials and methods: Between 2012 and 2013, 26 patients with solid renal masses suspected to be RCC on CT were screened for recruitment in this study. 2 patients were excluded from the study due to motion artefacts. Subjects were included if they had a solid renal mass less than 10 cm in size, suspected to be an RCC and showing greater than 20 HU enhancement on iodinated contrast CT image. The patient was required to be suitable and willing for surgery for removal of the renal mass with partial or radical nephrectomy. Patient with contraindication to MR studies (metallic implants, claustrophobia, pace-makers etc.) and azotemia were excluded. Prior to surgery, all patients underwent MR studies at 1.5 T (Siemens Healthcare, Avanto, Erlangen, Germany) using a whole body MR scanner with a surface coil for reception and a body coil for transmission. Following scout images, breath hold fat suppressed axial turbo spin echo T2-weighted images in three orthogonal planes were acquired (TR=2970-4000ms; TE=100ms). Breath-hold axial gradient echo T1-weighted images in axial plane were also acquired (TR=224ms; TE=7.2ms). DW images were acquired using respiratory triggered fat suppressed single-shot echo planar imaging using following parameters: TR=1700, TE=62ms, Averages=6 and two b values (0 and 500 s/mm^2). Circular ROIs of size of 1 cm^2 were drawn on the restricted diffusion and ADC values were recorded. Histopathology results after surgical resection were used as the reference standard. ADC values were calculated for both the RCC and contralateral normal kidney. This study was approved by the Institutional ethics committee and written informed consent was taken from all the patients. A p-value of < 0.05 was considered to be statistically significant. All the data analyses were performed using statistical software package SPSS (version 16.0).

Results: The data of 24 patients with the mean age of 50±11 years (range: 31-70 years; 18 male and 6 female) were finally analysed. Mean ADC showed marked restriction for RCCs as compared with healthy kidneys (Table 1). Moreover, ADC was significantly lower in non clear cell carcinoma patients as compared with clear cell carcinoma (Table 1). Nuclear grades I and II were pooled as low grade and nuclear grades III and IV were pooled as high grade RCC. Although, mean ADC was lower in high Fuhrman's grade of RCC compared with low grade RCC, the difference was not statistically significant (Figure 1, p=0.09). Figure 2 (a & b) shows the hyperintense area on the DW images and restriction on ADC map.

Discussion: Various studies have evaluated the role of DW MRI in characterizing the malignant tissues and have found a discriminating ability between benign, neoplastic tumors and normal tissues.[4] We found ADC values for RCC to be significantly lower than normal kidney tissue, and a similar findings were reported.[5] Lower ADC is attributed to increased cellularity and tissue disorganization. Further, Fuhrman's grading system utilises nuclear features with heavy chromatin clumps being observed in higher grades. ADC values differed among various RCC variants, non-clear cell RCC had significantly lower values compared to the clear cell variants. This difference may be due to the hypovascular nature of papillary and chromophobe RCC.[6] ADC values may also change with tumor nuclear grade. We observed lower ADC values in higher grade tumors as compared with low grade tumors.[7] Although, the result was not significant this could be significant in a larger dataset. Therefore, it could be possible that using DWI we may not only predict the nature of the renal mass but also the histological subtype and aggressiveness.

Conclusion: DW-MRI could be helpful in diagnosing RCC patients, prognostication of the patient and it has potential in guiding therapeutic decision.

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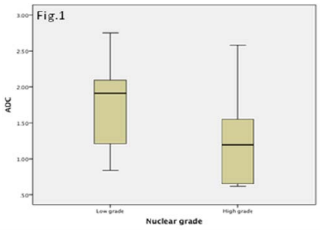
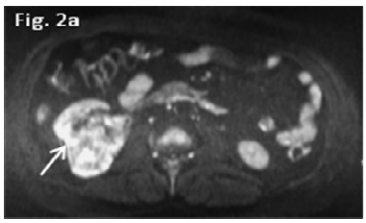
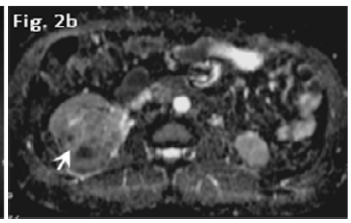


Figure 1: Above figure shows mean ADC between low grade and high grade RCC tumors; **Figure 2:** High grade RCC in a 52-year-old man. Transverse hyperintese area in right renal mass lesion, depicted by arrow (a), and restricted diffusion in right renal mass, depicted by small arrow.





	Normal Kidney (24)	RCC (24)	p-value
ADC ($\times 10^{-3}$ mm^2/s)	2.25 ± 0.29	1.51 ± 0.61	0.01
	Clear cell (17)	Non Clear cell (7)	p-value
ADC ($\times 10^{-3}$ mm^2/s)	1.74± 0.60	1.03 ± 0.29	0.006

Table 1: Mean ADC between normal kidney and malignant tumors